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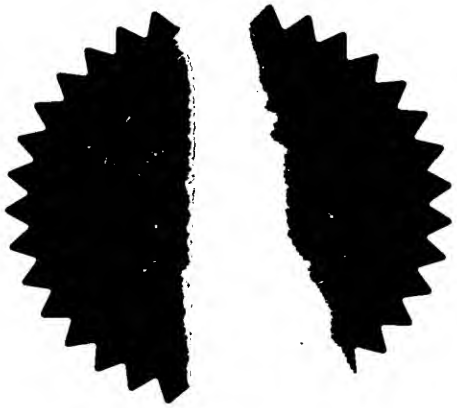

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PA4671

2. Patent application number
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3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

PressTech Controls Group Limited
PressTech House
Maxted Road
Hemel Hempstead, Hertfordshire, HP2 7ED
UK (A UK company)

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

08508495001

4. Title of the invention

IMPROVEMENTS TO SCANNING HEADS

5. Name of your agent *(if you have one)*

SOMMERVILLE & RUSHTON

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

45 Grosvenor Road
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FS1/72 24/4/03

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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Number of earlier application	Date of filing *(day / month / year)*

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a) any applicant named in part 3 is not an inventor, or
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Claim(s)	3
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Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	0
Request for preliminary examination and search *(Patents Form 9/77)*	0
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11. I/We request the grant of a patent on the basis of this application.

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Iain Whitaker
01727 854215

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IMPROVEMENTS TO SCANNING HEADS

Field of the Invention

The present invention concerns improvements in and relating to scanning heads such as, for example, those used in the print industry for detection of print registration marks or for fold-line registration. The scanning head may have a moving scanning component or, more normally for use in the print industry, be a static module with no moving components and where the mark to be monitored is on a substrate, eg a print web, that is moved passed the scanning head. The scanning head may have a single optical sensor or a plurality of optical sensors. The present invention further concerns print registration units for printing presses and a method for print registration.

Background to the Invention

As raw material and overall production costs rise and profit margins in the print industry are squeezed, the industry needs to make cost savings wherever available.

One area where technological advances afford cost savings is in the design of the printing press and print registration equipment. Through enhancements to the print registration equipment to, for example, more reliably ensure that each of the colour layers in a four colour print process are printed in register with each other as they are sequentially applied to the print web, minimising the wastage in each print run, considerable savings have been achieved. Examples of such enhancements to the print registration equipment are set out in European patents EP 0 340 897 and EP 0 403 082. In each case one or more arrays of optical sensors are deployed in one or more scanning heads overlying the print web to detect the print registration marks on the print web and a processor linked to the scanning heads monitors the signals from the sensors and determines when a sensor or group of sensors has sensed the passage of a print registration mark.

Although much improvement has been obtained in the operational efficiency and effectiveness of the print registration equipment, the hardware costs have not been as effectively addressed. It is, accordingly, one general objective of the present invention to provide for a more economical construction of print registration

equipment while maintaining the high standards of accuracy and reliability that the print industry has come to expect and require. It is a further general objective of the present invention to provide for a more compact construction of print registration scanning head.

Summary of the Invention

According to a first aspect of the present invention there is provided a scanning head suitable for use in a register mark detection apparatus for detecting register marks/ features on a web surface or other surface, suitably during relative movement between the surface and the scanning head, the scanning head comprising an optical sensor and a first optical mask having an aperture therethrough to define the viewing footprint of the optical sensor.

The optical mask serves, instead of focussing lenses or mirrors, to define the viewing footprint of the optical sensor, i.e. to delimit that part of the optical sensor sensory area that views received light. If any lens is present in the receiving optical path this is merely the lens face of the optical sensor. If any mirror is present in the receiving optical path this is suitably merely to re-direct but not focus the light.

The viewing footprint of the optical sensor is suitably substantially less than the sensory area of the optical sensor and preferably the scanning head is configured in use to view an area of the web (viewed footprint of the web) that is the same as or similar to the area of the registration mark on the web sought by the scanning head, in use.

Preferably the first optical mask is positioned at or near an optical opening into the scanning head and particularly preferably is, in use, positioned closely adjacent to and plane parallel to the web.

In the preferred embodiment the first mask is less than 10mm and preferably between 3 to 5mm from the web in use.

Suitably the scanning head further comprises a light source for illuminating a viewed footprint of the web, the light source preferably being a solid state, low power light source and particularly preferably comprising one or more LEDs.

Preferably the scanning head comprises a light source arranged in the scanning head to provide direct reflection illumination of the web. Suitably for transparent web media a mirror is provided in combination with the scanning head and placed on the opposite face of the web from the scanning head to reflect light back through the web to the scanning head.

Preferably the scanning head comprises a light source that is arranged in the scanning head to provide diffuse illumination of the web.

In one embodiment the scanning head has a white light source and the sensor is adapted to sense light across the visible spectrum.

Preferably the scanning head has a UV light source and the sensor is a UV sensor.

Preferably the scanning head comprises a plurality of light sources that may be selected between for use independently or together. Suitably at least two of the light sources differ from each other in wavelength of emitted light.

Preferably at least one of the plurality of light sources is arranged in the scanning head to provide direct reflection illumination of the web and another is arranged in the scanning head to provide diffuse illumination of the web.

Particularly preferably, the scanning head has a second mask with an aperture in series with the first mask. This further defines the viewing footprint of the optical sensor, enhancing sensitivity and accuracy. Furthermore, the use of multiple masks is not wavelength sensitive, facilitating scanning for different light wavelengths.

The second mask is preferably between the first mask and the sensor preferably closer to the sensor than to the first mask and preferably much closer to the sensor than the first mask is to the web, in use.

The spacing between the first mask and the second mask is preferably of the order of ten times greater than the spacing of the first mask from the web, in use. The area of the aperture of the second mask is preferably greater than that of the first mask and preferably by substantially the same ratio as the ratio of the spacing of the first and second masks relative to the spacing of the first mask from the web.

Particularly preferably the aperture of the mask or of at least one of the masks where there are two masks is of a shape that is the same as or similar to the shape of the registration mark sought on the print web, in use. Preferably the aperture of the mask or of at least one of the masks where there are two masks is of a shape that is composite, i.e. not merely a single line or square or circle but having multiple lines or portions (e.g. star-shaped or L or U shaped) or comprising multiple holes or slots/ slits. These refinements again enhance accuracy and reliability of registration mark detection.

Suitably the scanning head is configured to enable demounting of the mask(s) to enable interchange of masks with different aperture shapes or sizes.

According to a second aspect of the present invention there is provided a print registration device of a printing press comprising a scanning head of the first aspect of the invention, and according to a third aspect of the present invention there is provided a printing press comprising such a print registration device. The print registration device has or is operatively linked to a processor for monitoring the signals from the one or more sensors of the scanning head to detect registration.

Brief Description of the Drawings

The present invention will now be more particularly described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is a simplified schematic isometric view of components of a scanner head embodying the invention;

Figure 2 is a plan view of the arrangement shown in Figure 1; and

Figure 3 is a schematic view of the components assembled together in a working scanner head.

Description of the Preferred Embodiments

Referring firstly to Figure 1, this demonstrates the principle of the invention, showing a scanning head optical sensor 1, suitably a photosensitive diode, positioned over a print web 4 to receive light reflected back from a small area/ viewed footprint 5 of the web 1 that is suitably overlying and only marginally larger than the footprint of the registration mark on the web 4.

In complete contrast to the conventional scanning heads, there is no costly focussing lens or mirror spaced away from the optical sensor 1 to focus the light onto the optical sensor 1, although the sensor 1 may, as illustrated, have a small integral receiving lens. Instead of a costly separate lens or focussing mirror, the scanning head has sensor 1 with a high forward gain and a narrow beam width (e.g. 10°) and uses a pair of optical masks 2,3 positioned between the optical sensor 1 and the web 4 to block stray light from reaching the sensor 1.

The masks 2,3 each have a respective aperture 6,9 so that as the registration mark passes adjacent the sensor 1, the sensor 1 receives only light reflected back from the small viewed area 5 of the web 1 corresponding to the approximate footprint of the registration mark 5 on the web 4. Each of the apertures 6,9 is shown as being an elongate slot-shaped aperture. This suitably corresponds to the shape of the registration marks used on the print web 4.

For the first mask 2 that is closest to the web 4 the size of the aperture 6 is substantially the same size as the viewed footprint 5 on the web 4.

The first mask 2 is positioned plane parallel to the web 4 and is spaced a very short fixed distance of the order of a few mm from the web 4. The first mask 2 is responsible for primary discrimination of the registration mark 5 and is almost totally in focus as a result of being so close to the print web 4. In the illustrated example

the first mask 2 is spaced only 4mm from the web 4 and has an aperture 6 of 0.5x0.8mm corresponding to a viewed area 5 of 0.5x0.8mm.

Since during a print run the print web 4 experiences an oscillatory movement, known as print flap, that cyclically varies the spacing of the first mask 2 from the web 4 by a magnitude dictated by the mass, tension and rate of travel of the moving print web 4, the preferred scanning head positioning height tolerance (tolerance of spacing of the first mask 2 from the print web 4) is 3mm +/– 1mm.

The second mask 3 is positioned within a few mm of the sensor 1 and 40mm away from the first mask 2, aligned with the first mask 2 and the sensor 1 so that the light reflected from the print web 4, having passed through the aperture 6 of the first mask 2, must then pass through the aperture 9 of the second mask 3 to fall onto the sensory surface of the sensor 1.

As shown in Figure 1, the light reflected from the web 4 is restricted, by the first mask 2, to a beam demarcated within upper 7 and lower 8 boundary lines. In the plan view of Figure 2 the lateral boundaries of the beam are demarcated by boundary lines11,12. The umbra 13 and penumbra 14 of the target footprint/ imaged area 5 on the print web 4 crossover as the light passes through the aperture 6.

The second mask 3 restricts the light input to the sensor 1, while still allowing sufficient light for a good signal to noise ratio. Since the required final optical footprint will generally be small and non-circular, unlike the large diameter circular receiving lens/ sensing surface of the sensor 1, the second mask 3 will help optimise the match between the footprint defined by the first mask 1 and the large diameter circular receiving lens/ sensing surface of the sensor 1.

To optimise the overall sensitivity and selectivity of the receiver, the area of aperture 9 of the second mask 3 is scaled up relative to the area of the first mask's aperture 6 in correspondence with the ratio of Dimension 1 (the distance between masks 2,3) to Dimension 2 (the scanning head height above the web 4) and which is preferably of the order of 10 :1. Given that in the illustrated example Dimension 1 is 40mm and Dimension 2 is 4mm, and that the area of aperture 6 is 0.5x0.8mm, the selected size of the aperture 9 is suitably 1x4mm, ie ten times larger than the area of aperture 6.

By appropriate selection of the sizes of the mask apertures 6,9 and the ratio of Dimensions 1 and 2, the viewed footprint 5 is reduced to a very small area.

Further optimisation is obtained by shaping the apertures 6,9 to the shape of the registration mark to be detected. The illustrated 0.5x0.8mm aperture 6 of the first mask 2 may, for example, without changing the overall viewed footprint area 5, be adjusted to a 0.1x4mm slit suitable for use where the print registration mark is a line. For a star-shaped print registration mark the aperture 6 would suitably also be star-shaped. This can yet further enhance the reliability of registration mark detection.

The aperture 6 could be comprised of an array/ grouping of small apertures configured to replicate an array/ group of discrete elements/ lines comprising a composite print registration mark. For example, there may be two parallel slots comprising the aperture 6 in the mask 2 to correspond to two parallel lines of a print registration mark on the print web 4, and this will provide even higher reliability of print registration than a single slot corresponding to a single line mark.

For adaptability in use the apparatus is suitably configured for interchangeability of the mask 6, and suitably also of mask 9, with replacement masks having alternative shapes/ configurations of aperture.

Referring to Figure 3, the preferred embodiment of scanning head has a compact construction with the sensor 1 and masks 2,3 held within a housing 20 in the same relative positions as in Figures 1 and 2 but with the line between the first mask 2 and second mask 3 folded by a simple low cost (non focussing) mirror 18, to render the head even more compact.

For optimal versatility, one or more of the sensor 1 and masks 2,3 may be demountable from the housing 20 and/or adjustable in position within the housing 20 to allow the user to tune the head for a particular requirement.

To illuminate the viewed footprint area 5 of the print web 4, the scanning head has, as a light source, a pair of wide angle LEDs 15,16 mounted within the housing adjacent the receiving components (sensor 1 and masks 2,3) but shielded from them by a barrier wall 19. These two LEDs 15,16 can be substantially identical, emitting light of the same wavelength and intensity as each other but importantly

they differ in their mounting angles within the housing 20 to enable the scanning head to have two primary different modes of operation.

First LED 15, for diffuse mode operation, is mounted within housing 20 with its axis tilted at 45° to the normal of the bottom face of the housing 20, thereby being at 45° to the normal of the web 4, since the bottom face of the housing 20 is plane parallel to the web 4. This first LED 15 has thus no direct reflective path via the scanned media/ print web 4 into the optical receiver window through the aperture 6 of the first mask 2. It functions to provide a diffused light source for the scanning operation that is particularly suitable for registration mark detection on printed paper, holograms and embossed media.

Second LED 16, for direct reflection mode operation, is mounted within housing 20 with its axis tilted at 10° to the normal of the bottom face of the housing 20, thereby being at 10° to the normal of the web 4 and facilitating direct reflection from the web 4 into the optical receiver window. This LED 16 is particularly useful for scanning reflective media or printed marks on transparent media. In the latter case a mirror backing plate 17 positioned underlying the transparent media may be used to reflect the light to the optical receiver window. In operation of the second LED 16 the angle of incidence and angle of reflection through the optical path from the transmitter light source LED 16 to the optical light receiver/ aperture 6 are equal.

The scanner head height and position of the LEDs are suitably arranged so that the area of the print web 4 illuminated by the LEDs is of sufficient size to accommodate the viewed footprint/ mask aperture 6 footprint, with additional allowance being made for the scanner head height tolerance and web flap referred to earlier.

The scanning head is configured to enable switch selection between the light sources/ modes of operation, with the first or second LED 15,16 being selected dependent upon the media to be scanned. Indeed, a mix of light from both first and second LEDs15,16 simultaneously may be used to suit some media and for greatest versatility the wavelengths and intensities of the light sources are suitably adjustable. For this the first and second LEDs15,16 may each be part of a respective group of LEDs, one group at the 10° angle or a similar angle for direct reflection operation and the other at the 45° angle or a similar angle for diffused light

operation, with the LEDs within each group differing in wavelength output from each other and individually selectable for use alone or in combination with others.

One of the LEDs in each group may, for example, emit one specific visible spectrum coloured light, e.g. red, while another emits a different specific visible spectrum coloured light, e.g. green, or even, in one particularly preferred arrangement, UV light when the sensor 1 incorporates a UV optical receiver.

A white light LED can alternatively be used when the receiving optical sensor 1 is an eye colour response detector adapted to sense light across the whole visible spectrum. Where the LED emits one specific visible spectrum coloured light the colour suitably is in contrast to the media under view to increase detection sensitivity, allowing detection of very pale shades. Single or multiple combinations of colours may be used to optimise the contrast with the media under view.

A UV based detection system enables registering of UV reflective clear inks, varnishes, lacquers, cold seals, glues and other clear media that cannot readily be registered with conventional visible light based systems. The provision of a UV emitting LED and corresponding receiver in a scanning head of the present invention is especially useful since it provides an exceptionally cost effective UV detection system, with the masks 2,3 avoiding the need for multiple quartz lenses and still enabling the scanning head to focus on very small media marks.

Alternatively or additionally, varnishes, lacquers, cold seals, glues and other clear media may be scanned using a white light emitting LED, adjusting the light level from the LED appropriately.

In operation of the scanning head as part of a print registration detection apparatus, or for other purposes, the required scanning head function can be met through controlled illumination. With the general exception of UV mode, the parameters of the optical sensor remain the same for the different modes.

In general, the analogue output signal of the receiver/ sensor is proportional to the contrast ratio and/ or embossed relief profile of the scanned media/ print web as viewed within the viewing footprint of the sensor. To allow for differences in contrast

and reflectivity of different media, the analogue output signal of the receiver/ sensor is suitably gain-controlled.

In the example of a print registration detection apparatus, the linear travel of the web gives rise to a sensor signal that varies with time as the registration mark comes into view and then passes the scanning head. The analogue sensor output signal is normally converted to a digital signal by an AD converter and then analysed by a processor/ software that is normally a part of the print registration detection apparatus or at least operatively linked to it, to discriminate the characteristics of different print registration marks and activate subroutines/ controllers for positional feedback control of the printing press. In some systems the analogue signal can be analysed by an analogue processor.

Beyond benefits already discussed, the principle of operation of the scanning head, enabling use of very low power solid state illumination, gives rise to a further unique benefit, namely the inherent intrinsic safety of the scanning head. It may be operated in potentially explosive atmospheres via a certified power limiting protection barrier unlike the conventional scanning heads with incandescent/ tungsten bulbs which require more power than can be supplied through such a certified power limiting explosion protection barrier.The prior systems can generally only be operated in an explosion risk environment by using of a weighty, bulky and costly explosion proof casing or long optical fibre to carry the light from a remote light source outside of the risk area.

The solid state illumination using LEDs also saves dramatically on maintenance of the light source, since the LEDs have an exceptionally high longevity, exceeding 100,000 hours of working life.

As noted above, the scanning head of the present invention provides a highly effective system for print registration in a printing press. The assembly is simple, efficient, effective, versatile and very economical both to install and run, is lightweight, is very compact and may readily be used in explosion risk environments and achieves high standards of accuracy and reliability with a wide range of media. Indeed, the ability to manufacture the masks 2,3 to close tolerances enables even greater accuracy in defining optical rise and fall times than conventional registration detection apparatus, giving greater accuracy in the registration measurement.

Claims

1. A scanning head suitable for use in a register mark detection apparatus for detecting register marks/ features on a web surface or other surface, the scanning head comprising an optical sensor and a first optical mask having an aperture therethrough to define the viewing footprint of the optical sensor.

2. A scanning head as claimed in claim 1, wherein the first optical mask is positioned at or near an optical opening into the scanning head.

3. A scanning head as claimed in claim 1 or 2, wherein the first optical mask is, in use, positioned closely adjacent to and plane parallel to the surface.

4. A scanning head as claimed in claim 1, 2 or 3, wherein the first mask is less than 10mm and preferably between 3 to 5mm from the surface in use.

5. A scanning head as claimed in claim 1,2,3 or 4, wherein the scanning head further comprises a light source for illuminating a viewed footprint of the surface, the light source being a solid state, low power light source.

6. A scanning head as claimed in claim 5, wherein the light source comprises one or more LEDs.

7. A scanning head as claimed in any preceding claim and having a light source, wherein the light source is arranged in the scanning head to provide direct reflection illumination of the surface.

8. A scanning head as claimed in claim 7, wherein for transparent web media a mirror is provided in combination with the scanning head and placed on the opposite face of the web from the scanning head to reflect light back through the web to the scanning head.

9. A scanning head as claimed in any preceding claim and having a light source, wherein the light source is arranged in the scanning head to provide diffuse illumination of the surface.

10. A scanning head as claimed in any preceding claim, wherein the scanning head has a UV light source and a UV sensor.

11. A scanning head as claimed in any preceding claim, wherein the scanning head has a white light source.

12. A scanning head as claimed in any preceding claim, wherein the scanning head comprises a plurality of light sources that may be selected between for use independently or together.

13. A scanning head as claimed in claim 12, wherein at least two of the light sources differ from each other in wavelength of emitted light.

14. A scanning head as claimed in claim 12 or 13, wherein at least one of the plurality of light sources is arranged in the scanning head to provide direct reflection illumination of the surface and another is arranged in the scanning head to provide diffuse illumination of the surface.

15. A scanning head as claimed in any preceding claim, wherein the scanning head has a second mask with an aperture in series with the first mask.

16. A scanning head as claimed in claim 15, wherein the second mask is between the first mask and the sensor, closer to the sensor than to the first mask.

17. A scanning head as claimed in claim 15 or 16, wherein the second mask is much closer to the sensor than the first mask is to the surface, in use.

18. A scanning head as claimed in claim 17, wherein the spacing between the first mask and the second mask is of the order of ten times greater than the spacing of the first mask from the surface, in use.

19. A scanning head as claimed in claim 16, wherein the area of the aperture of the second mask is greater than that of the first mask and by substantially the same ratio as the ratio of the spacing of the first and second masks relative to the spacing of the first mask from the surface.

20. A scanning head as claimed in any preceding claim, wherein the aperture of the mask, or of at least one of the masks where there are two masks, is of a shape that is the same as or similar to the shape of the registration mark sought on the surface, in use.

21. A scanning head as claimed in any preceding claim, wherein the aperture of the mask or of at least one of the masks where there are two masks is of a shape that is composite, i.e. not merely a single line or square or circle but having multiple lines or portions (e.g. star-shaped or L or U shaped) or comprising multiple holes or slots/ slits.

22. A scanning head as claimed in any preceding claim, wherein the scanning head is configured to enable demounting of the mask(s) to enable interchange of masks with different aperture shapes or sizes.

23. A scanning head substantially as hereinbefore described with reference to the accompanying drawings.

24. A print registration device of a printing press comprising a scanning head as claimed in any preceding claim.

25. A printing press comprising a print registration device as claimed in claim 24.

ABSTRACT

IMPROVEMENTS TO SCANNING HEADS

The present invention provides a scanning head for use in a register mark detection apparatus for detecting register marks on a web during relative movement between the web and the scanning head, the scanning head comprising an optical sensor and a first optical mask having an aperture therethrough to define the viewing footprint of the optical sensor. The scanning head is compact, inexpensive and capable of multi-mode operation as well as being capable of intrinsically safe operation using an internal LED light source. The scanning head is versatile and capable of operating with high sensitivity and accuracy even with low contrast media, including with embossed/ relief marks or for fold-line registration or with translucent media.

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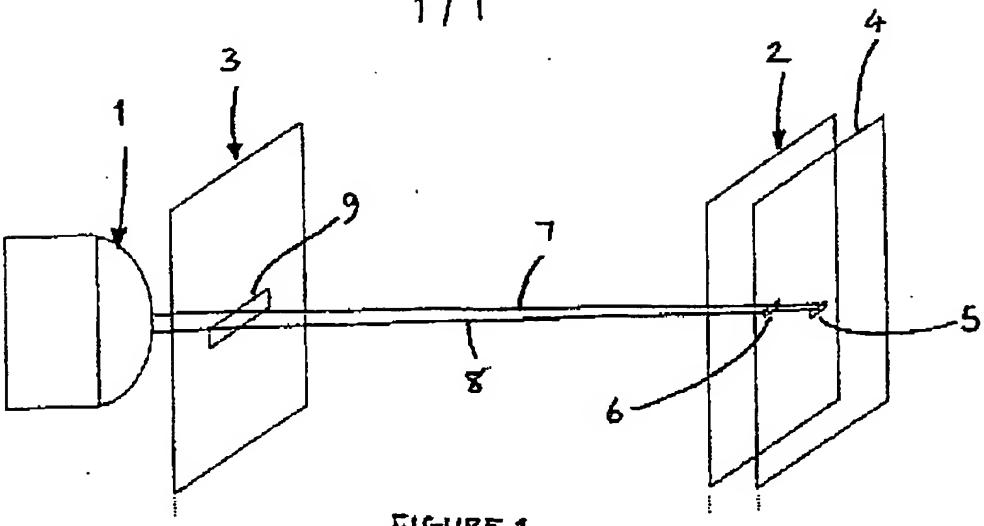

FIGURE 1

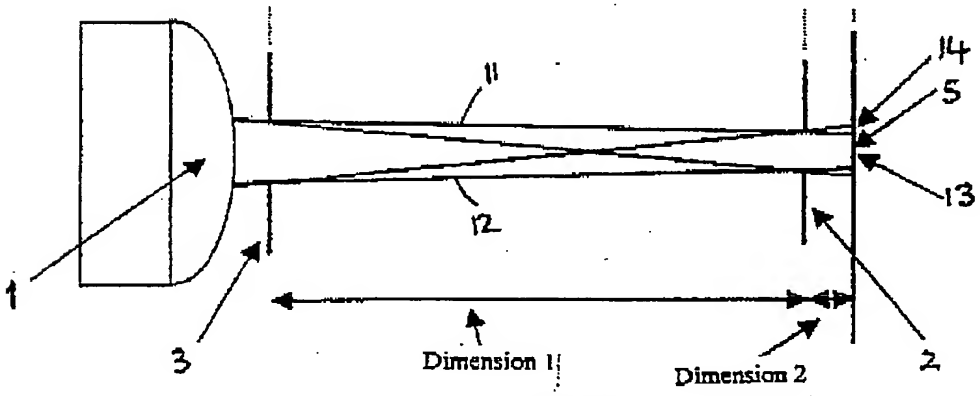

FIGURE 2

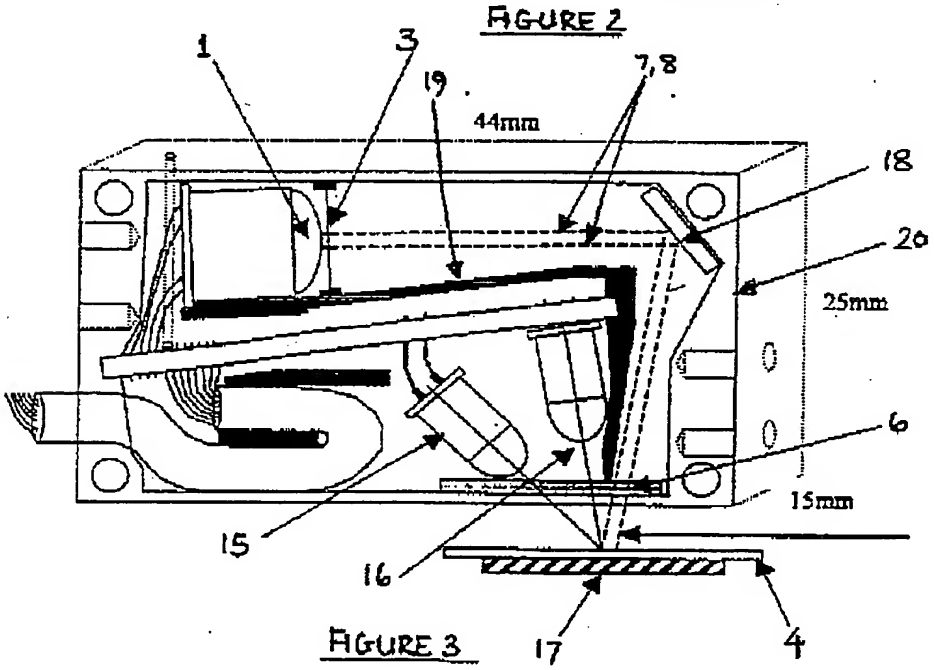

FIGURE 3